Interferential Therapy

Therapy manual

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Disclaimer

Before you start treating a patient you must be familiar with the operating procedures for each treatment and with the indications, contra-indications, warnings and precautionary measures. For additional information about he use of interferential therapy, consult other sources.

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Preface

This therapy manual is primarily intended to give background information in connection with the use of interferential treatment units (like Endomed and Sonopuls combination units). With a view to the demand for basic information about Interferential Therapy, we feel obliged to provide more detailed explanation about this subject.

In compiling this booklet it has been assumed that the reader possesses a basic knowledge of neuro-physiology. It should be noted however that the information is not intended to be exhaustive.

January 2004 Enraf-Nonius B.V.

1 Chapter 1 medium-frequencey currents

In electrotherapy a distinction can be made between medium-frequency and low-frequency currents. Traditionally used low-frequency currents include:

- faradic
- sinusoidal
- interrupted or continuous D.C.
- diadynamic,
- ultra-stimulation (2-5)
- "TENS" currents.

These -currents all have frequencies of -less than 1,OOOHz.

The low-frequency current used for therapy is a direct current (continuous or interrupted) or a rectified alternating current.

In medium-frequency electrotherapy alternating currents are used.

Therapeutic medium-frequency currents are generally A.C. or rectified A.C. of over 1 ,OOOHz. Theoretically the range of medium-frequency currents lies between 1,000 and 100,OOOHz Wyss although Gildemeister suggests a lowest frequency of 2-3,OOOHz.

The distinctions of these frequency ranges are based on the difference in physiological effects between stimulation with medium-frequency currents and stimulation with low-frequency currents.

Cycle-synchronous depolarization takes place when nerve fibres are stimulated with a low-frequency current (interrupted D.C.). According to this principle every pulse of direct or alternating current causes a depolarization of the nerve fibre (provided the duration and strength of the pulse are sufficient).

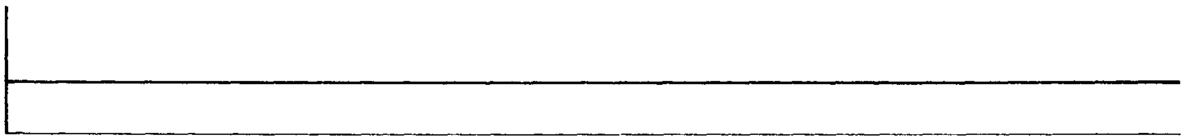

Figure 1.1 Direct current

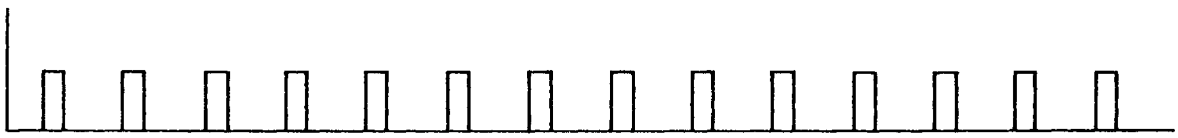

Figure 1.2 Interrupted direct current

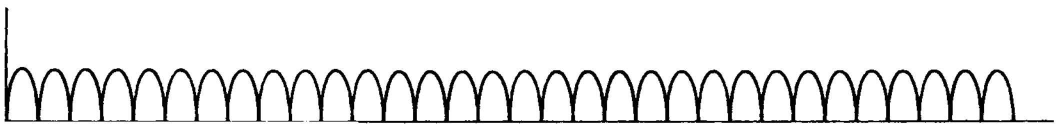

Figure 1.3 Rectified alternating current

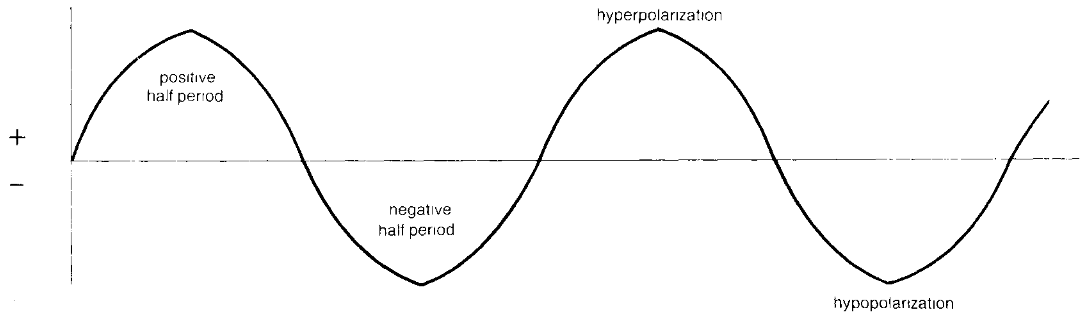

Figure 1.4 Sinusoidal alternating current

Action potentials will be generated in the nerve in a rhythm synchronous to the frequency of the current. If the stimulation frequency becomes higher the depolarization frequency will increase correspondingly. Every nerve fibre, however, has its maximum depolarization frequency. This frequency is determined by the refractory period. For the largest myelinated nerve fibres this maximum frequency is located between 800 and 1,000 Hz.

During electrical stimulation of nerve fibres with a frequency over 1,000 Hz a number of pulses will occur in the *refractory* period, i.e.: not every alternating-current pulse causes a depolarization. Depending on the duration of the refractory period, the nerve will not react to every pulse but react to the stimulation current at its own frequency.
The depolarization frequency of the nerve no longer coincides with the frequency of the current, nor with the depolarization frequency of other nerve fibres in the nerve bundle.

This phenomenon is called asynchronous depolarization (see figure 1.5a,b,c, and d).

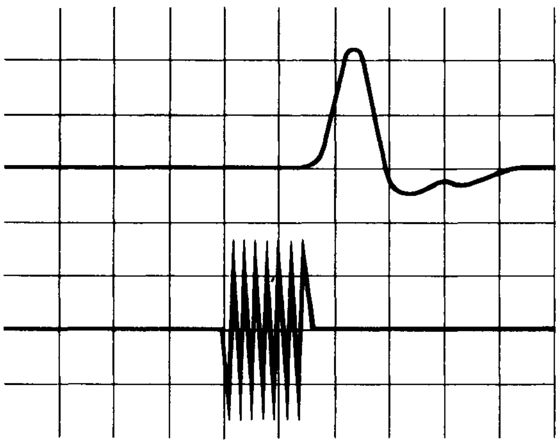

Figure 1.5a

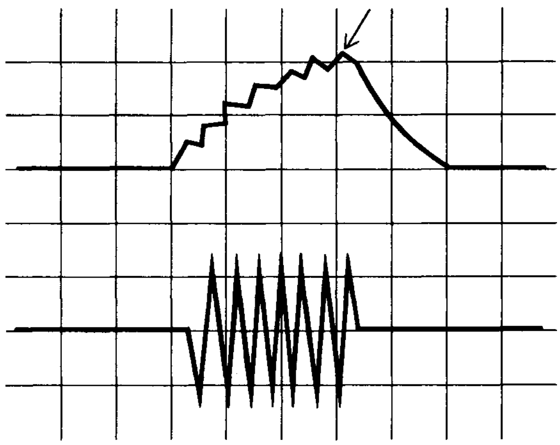

Figure 1.5b

Figure 1.5a
Shows the effect of a medium-frequency current on the sciatic nerve of a frog. This 5000 Hz current does not generate an action potential until after a certain number of cycles, and hence an “ Effective time ”

Figure 1.5b
Shows the effect of a direct-current pulse of he same total duration. It generates an action potential at moch lower current intensity.

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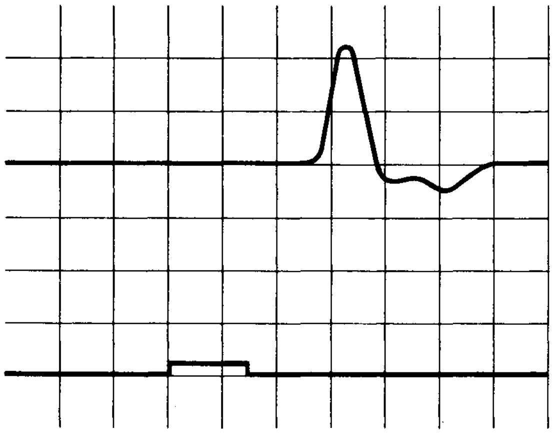


Figure 1.5c

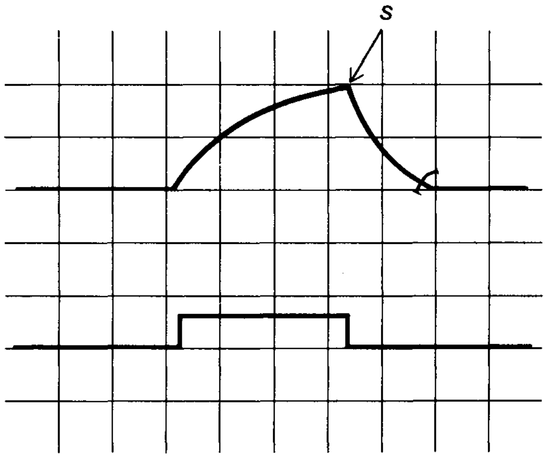


Figure 1.5d

Figure 1.5c
Refers to a laboratory model with similar currents being applied to charge a capacitator via a diode. The values remaining in the capacitor with every negative half-cycle eventually summate until a particular voltage is achieved, generating an action potential.

Figure 1.5d
Refers to a laboratory model with similar currents being applied to charge a capacitator via a diode. Similarly as 1.5c, but a lower intensity D.C. pulse of the same duration will also generate an action potential.

1.1 Gildemeister effect

Synchronous depolarization changes into asynchronous depolarization as the frequency increases. During stimulation with medium-frequency alternating currents not every cycle will result in a depolarization of the nerve fibre. The summation of several cycles is needed to depolarize the fibre. According to Lullies, the negative half-cycle has a greater hypopolarizing effect on the membrane potential than the positive half-cycle. After every cycle of an alternating current the potential difference will decrease slightly and approach the threshold value. After a number of alternating-current cycles (after a certain effective time) the threshold value is reached, resulting in a depolarization of the nerve fibre. The higher the intensity of the current, the shorter the "effective time" will be. Depolarization of nerve fibers according to this summation principle, is known as the *Gildemeister effect.*

1.2 Wedensky inhibition

If a nerve fibre is stimulated for a certain time with a medium-frequency alternating current of a constant intensity, the fibre initially discharges with its maximum frequency.

If the intensity of the current is high enough, it is possible that a depolarization will occur even in the (relative) refractory period.

According to Lullies, continuous stimulation with a medium-frequency current can give rise to a condition in which the nerve fibre ceases to react to the current, or the motor end-plate becomes fatigued and transmission of the stimulus may not take place.

It has been found that a muscle, despite the continuing supply of a medium-frequency alternating current, shows reduced contraction and finally ceases to contract. This phenomenon can have two causes:

A) If during stimulation one or more pulses occur in the refractory period, the repolarization of the nerve fibre within that period will become more difficult or be prevented. The return of the membrane potential to its rest potential takes longer and longer until it is finally no longer reached. Continuous stimulation with a medium-frequency current can thus lead to inhibition of the reaction or to a complete blockage throughout the duration of the stimulation. This is called *Wedensky inhibition*

B) The fatigue of the motor end-plate increases as the frequency of indirect electrical stimulation increases. The fatigued motor end-plate is no longer able to convert every pulse into a depolarization of the opposite muscle-fibre membrane.

To prevent Wedensky inhibition and fatigue of the motor end-plate, it is necessary to interrupt the medium-frequency current after every depolarization. Repolarization can then be effected and the tissue remains sensitive to stimulation. This rhythmic interruption will cause the fibres in the nerve bundle to depolarize at the frequency of interruption (see figure 1.6).

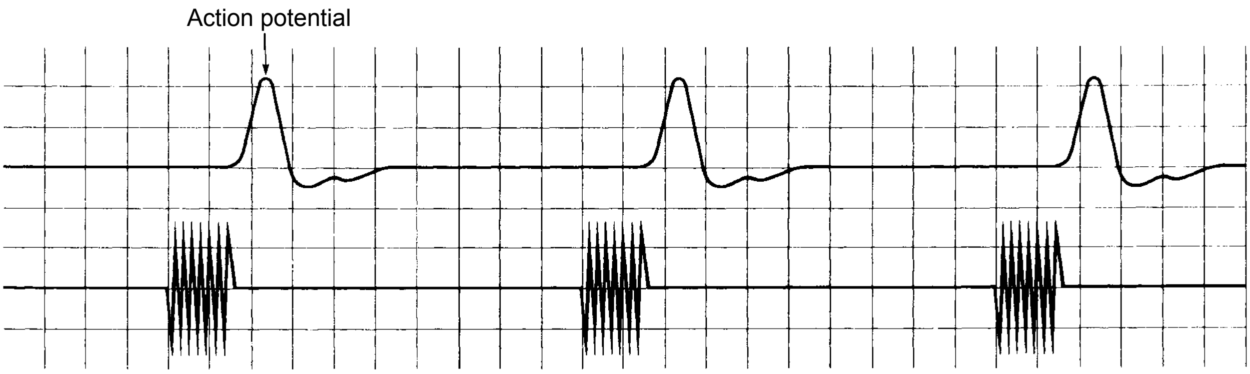


Figure 1.6 Rhythmic interruption of the MF-current

2 Chapter 2 Electrical explanation

2.1 Amplitude modulation

To allow repolarization the medium-frequency current has to be interrupted after every depolarization, or the intensity of the current has to be decreased significantly. The rhythmic increase and decrease of the intensity is called *amplitude modulation.* The frequency of the amplitude modulation (treatment frequency) determines the frequency of depolarization. The two frequencies are similar. Interferential therapy provides this specific modulation.

Definition: 'Interferential current' is the phenomenon which occurs when two or more oscillations are applied simultaneously to the same point or series of points in a medium.

In the interferential therapy method, two medium-frequency alternating currents that interact with each other are used. One of the alternating currents has a fixed frequency of 4,000 Hz while the frequency of the other alternating current can be set between 4,000 and 4,250 Hz. The superimposition of one alternating current on the other is called interference (see figure 2.1 a and 2.1 b).

At the point where the currents intersect, a new medium-frequency alternating current is set up whose amplitude voltage is modulated. The frequency of the new medium-frequency alternating current can be calculated as follows:

Formula: $\frac{f1 + f2}{2} = f1 + \frac{1}{2}\Delta f$

Δf represents the difference between the original frequencies.
Example: f1 = 4,000 Hz
f2 = 4,150Hz

$f1 + 1/2\Delta f = 4{,}000 + 75 = 4{,}075$ Hz (Resultant Carrying Frequency)

The frequency with which the amplitude varies is referred to as the amplitude modulation frequency (AMF). In interferential therapy the AMF (treatment frequency) corresponds to frequencies which are used in low-frequency electrotherapy.

The AMF has a value of: AMF = Δf =f1 – f2
Example: f1 = 4,000 Hz
f2 = 4,150 Hz
$|f1 - f2| = |4{,}000 - 4{,}150| = 150$ Hz (AMF or treatment frequency)

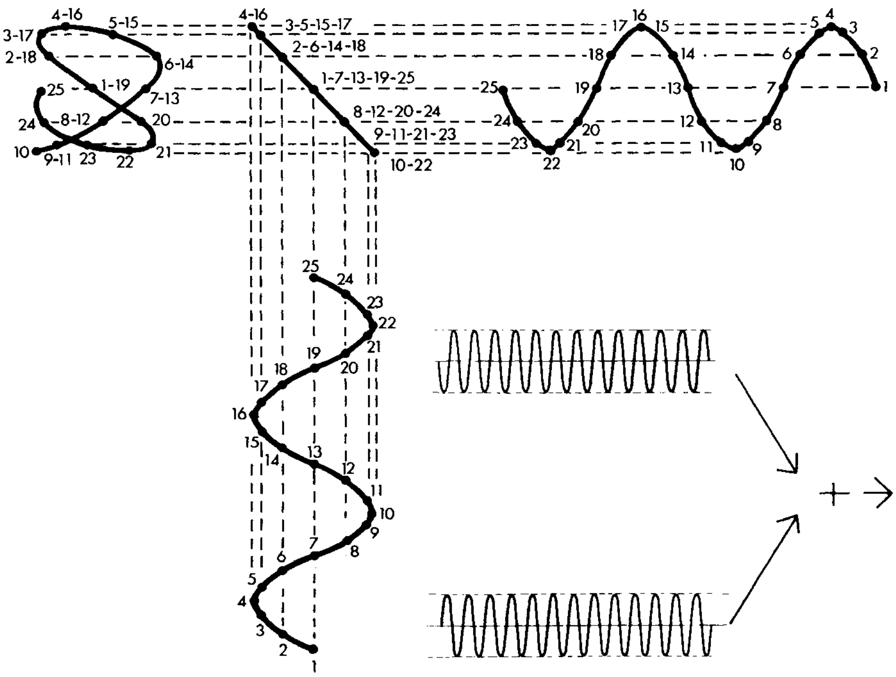


Figure 2.1a perpendicular superimposition

Figure 2.1b linear superimposition

2.2 Modulation depth and current intensity

Besides the frequency of the modulation the amplitude modulation is also caracterized by the *depth* of the modulation (M). The modulation depth is expressed as a percentage and can lie between 0 and 100% (see figure 2.2). According to Edel, a large modulation depth is preferable for therapeutic purposes.

The following methods are used in interferential therapy:

A) *The two-pole method*

Two electrodes are used in this method and the two alternating currents are superimposed inside the equipment. The signal leaving the equipment is modulated (see figure 2.3). With the two-pole method the depth of modulation in the tissue has the same value in all directions. The depth of modulation is always 100% (see figure 2.4 on page 7).
The amplitude, however, varies between 0 and 100% (the amplitude is the maximum current intensity). The amplitude is greatest in the direction of the line joining the two electrodes and zero in the direction perpendicular to that line (see figure 2.5 on page 7).

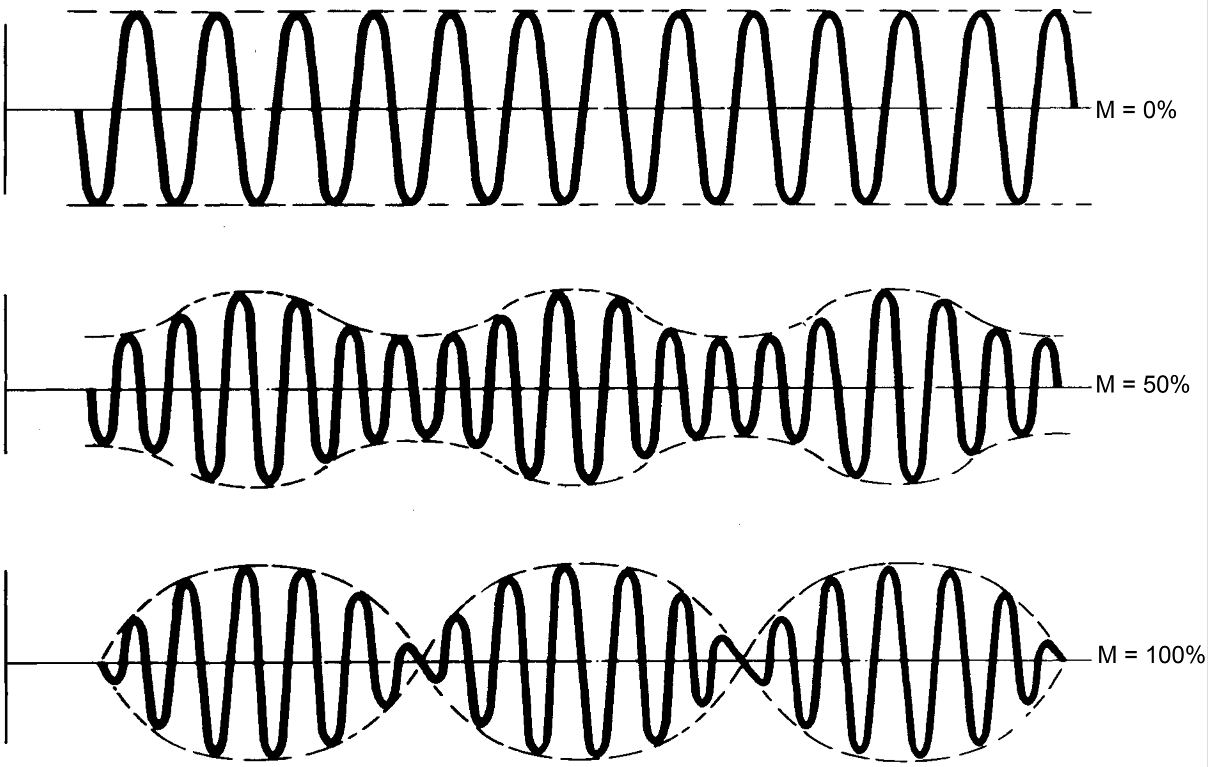


Figure 2.2 Different depths of modulation (M) of a medium-frequencey alternating current

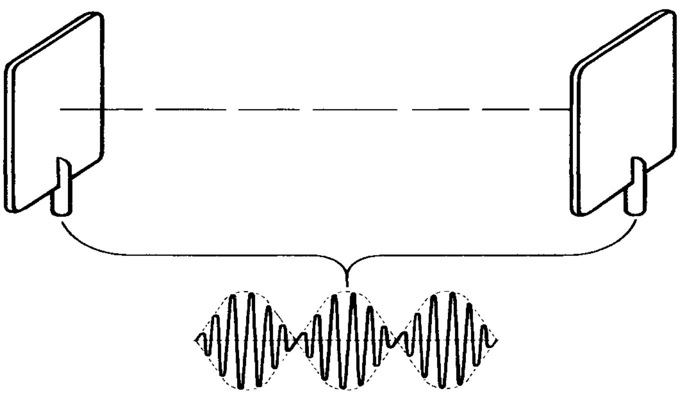


Figure 2.3 Linear superimposition (2-pole technique)

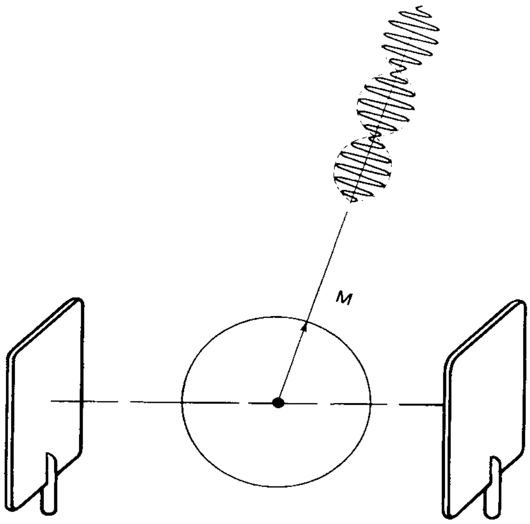


Figure 2.4 The modulation depth (m) is 100% in any direction (2-pole technique)

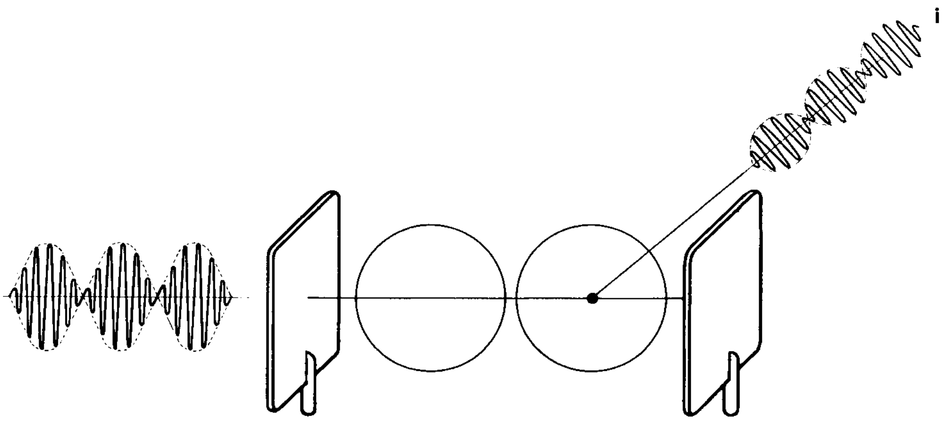


Figure 2.5 Distribution of the current intensity (i) with linear superimposition (2-pole technique)

B) The four-pole method

With this method four electrodes are used and two unmodulated alternating currents are supplied from the equipment in separate circuits. Where these currents intersect in the tissue, interference occurs (figure 2.6). The depth of modulation depends on the direction of the currents and can vary from 0 to 100%. When two equal forces (circuits) intersect at 90° the maximum resultant force is halfway between these two forces (45° diagonally from each circuit).

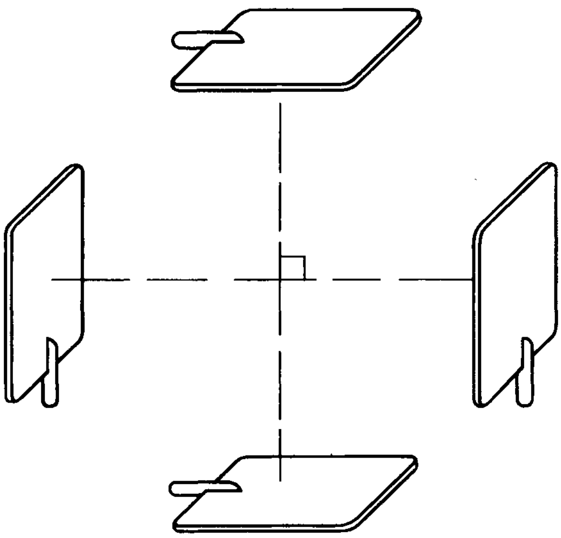


Figure 2.6 Perpendicular superimposition (4-pole technique)

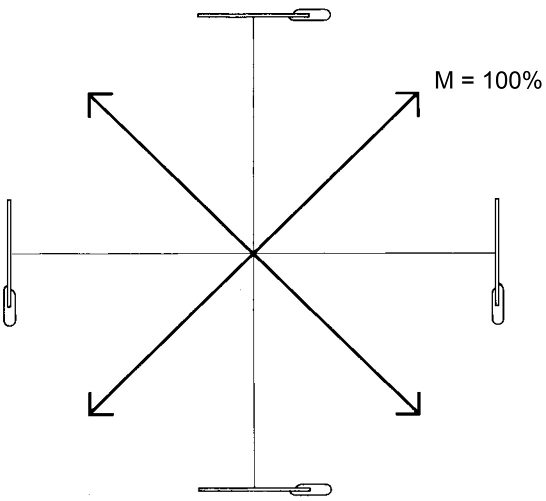


Figure 2.7 With perpendicular superimposition the modulation depth (M) is 100% on the 45° diagonals (4-pole technique)

The magnitude of M (modulation depth) in the various directions is shown in a polar diagram (figure 2.8).
The magnitude of the amplitude (i) can also be shown in a similar diagram (figure 2.9).
The position of the lines on which the depth of modulation is 100% and the amplitude greatest, will depend on the positioning of the four electrodes.

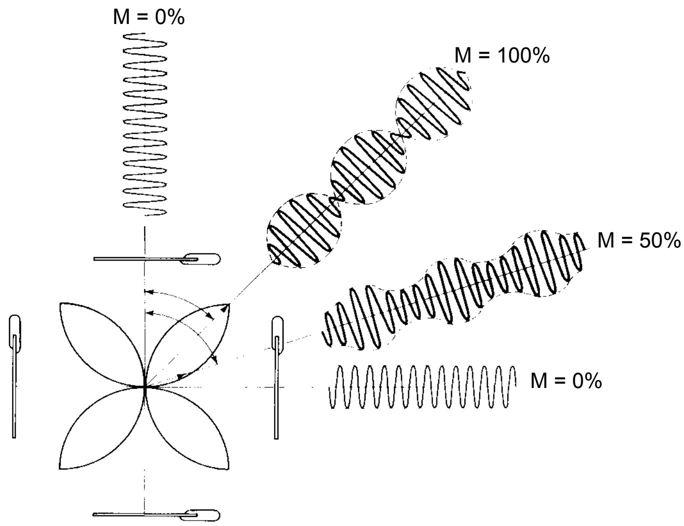


Figure 2.8 Polar diagram of the modulation (M) (4-pole technique with perpendicular superimposition

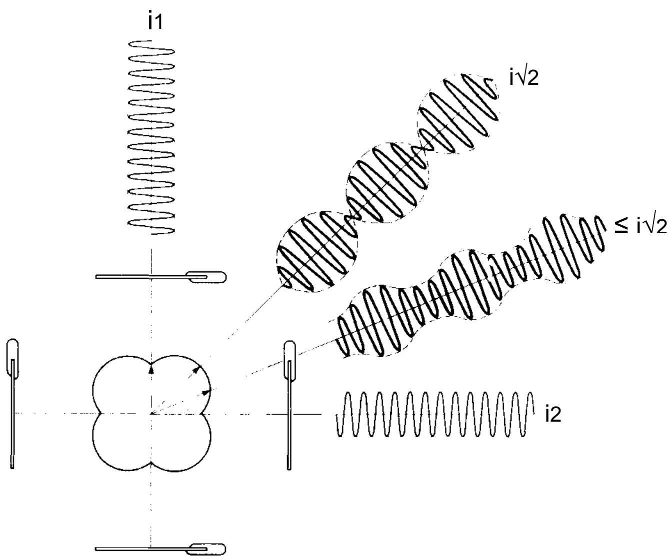


Figure 2.9 Polar diagram of the curent intensity (i) (4-pole technique) with perpendicular superimposition

C) The four-pole method using the automatic vector scan

The automatic vector scan is developed to increase the region of effective stimulation. The current intensity in the red circuit varies slowly between 50 and 100% of the maximum set value (see figure 2.10). The current intensity in the black circuit is set automatically to 75% of the maximum current in the varying circuit.The direction in which the depth of modulation is 100% depends on the ratio between the two currents i 1 and i 2 (see figure 2.11).
As a result the area of maximum stimulation rotates back- and forwards in the region of intersection, (see figure 2.12). Accurate positioning of the electrodes remains important, since there are zones in which the stimulation is not optimum.

The patient must experience the varying sensations of the current.

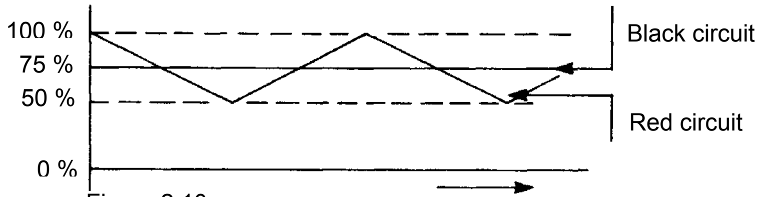


Figure 2.10

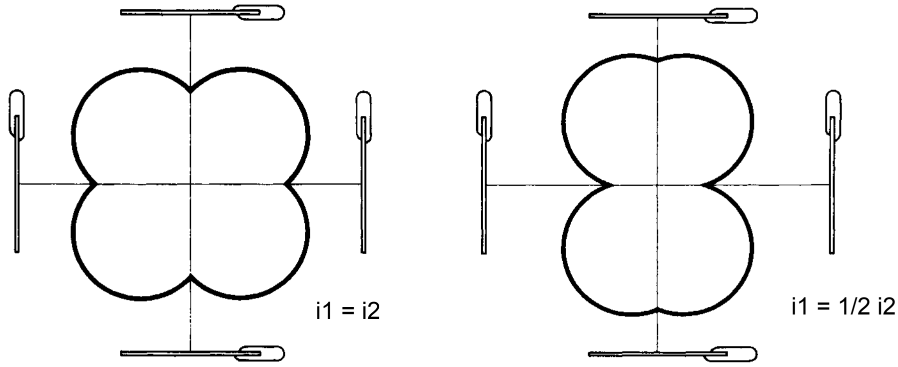


Figure 2.11

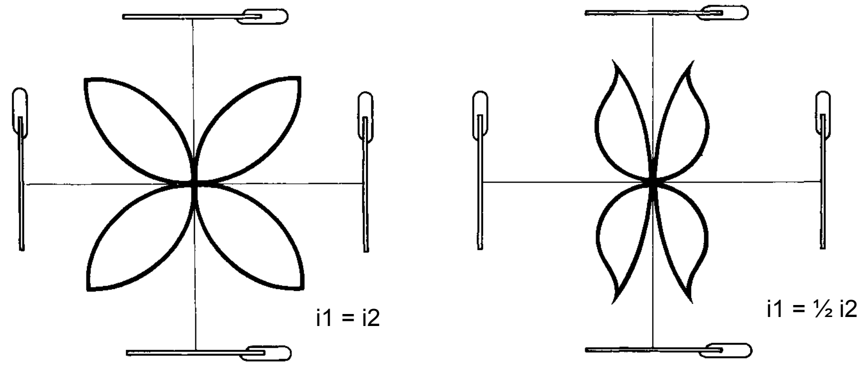


Figure 2.12

2.3 Depth effects

2.3.1 Introduction

Points of application for therapeutic treatment can be located superficial or deep in the tissues. The depth at which therapeutic effects are achieved, is determined by:

1. the frequency
2. the galvanic-current properties of direct currents.

To stimulate the skin sensors, currents with superficial effects are used. *A continuous galvanic current* has a clearly observable stimulating effect on the skin. An interrupted galvanic current and a rectified low-frequency alternating current also have this effect in addition to stimulation generated by the interruptions. Due to the stimulating effect on the skin, these currents are most suitable for treating skin regions and subcutaneous tissues.

If the tissue to be treated is located at a greater depth, e.g. in muscles, nerves, tendons, bursae or the periosteum, it is essential that the current has a great depth effect and little effect on the skin.

A medium-frequency alternating current, with its higher frequency and the absence of direct-current properties, is therefore the most suitable for treating deeper layers of tissue (see paragraphs 2.3.2 en 2.3.3).

2.3.2 Frequency

When interrupted direct currents or alternating currents are used, the *resistance* of the tissue *decreases* as the *frequency increases.* This is due to the fact that interfaces between different types of tissue and membranes in the tissue are not very permeable to ions, which are the agents for current conduction. The result is an accumulation of ions at the interfaces and the development of a potential difference (Up) which is opposite to the applied voltage (U) (see figure 2.13). This phenomenon is known as (electrolytic) polarization.

In this respect the tissue is comparable to a conductor with capacitance which is charged by an applied voltage and develops a counter-voltage. The counter-voltage can be assumed as an opposition, a reactance or capacitive resistance. Tissue has a certain polarizing capacitance which is referred to by the constant C, which depends on the surface of the electrodes.
The skin with its numerous connected cell layers can be easily polarized. The reactants and capacitance of human skin are primarily determined by the very poorly conducting stratum corneum (outer layer) of the epidermis. The resistance of undamaged skin is considerably lower for short bursts of currents and alternating currents of higher frequency than for an interrupted direct current.

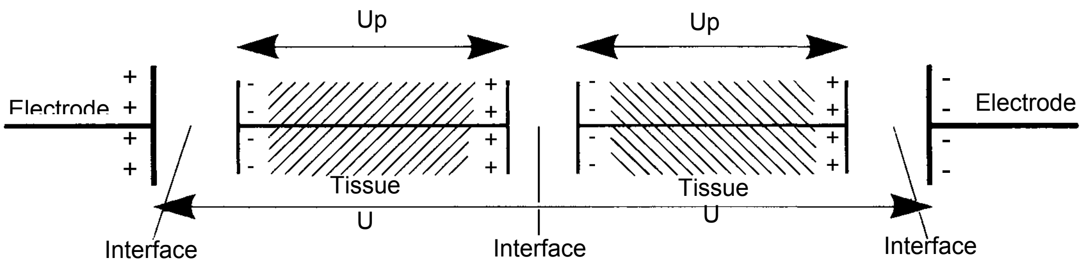


Figure 2.13 U is the applied voltage
Up is the potential difference

The marked drop of the reactance at increased frequency is shown in the following formula:

$$X = \frac{1}{2\text{Pi}fC}$$

X = capacitive resistance (reactance)
f = frequency of the current
C = polarization capacitance of the tissue.

It is assumed that for a contact area of 100 cm^2 the capacitance formed by the skin is 1 microfarad.

For a 50-Hz alternating current we obtain:

$$X = \frac{1}{2.\text{Pi}50.10^{-6}} = 3200\ \Omega$$

For a 4,000-Hz alternating current this means:

$$X = \frac{1}{2.\Omega 4{,}000.10^{-6}} = 39{,}8\ \Omega$$

This remarkable decrease of the capacitive resistance explains the greater ease with which the current passes through the skin at higher frequencies. In addition to the capacitive resistance there is also an ohmic resistance Ri, which is determined by the pores in membranes and folds of tissue allowing the ions to pass through more or less easily.

Every kind of tissue has, additionally, a "basic" resistance, the (pure) ohmic resistance R, which in the above example has a value of approximately 1 KOhm.

The resistance which a current can encounter in the tissue (see figure 2.14 and 2.15) can be represented schematically as follows:

If the tissue resistance is measured with high-frequency alternating currents, one is left with the "basic" resistance R of the tissue (the capacitive resistance is practically negligible) (see figure 2.16).

Medium-frequency alternating currents have a smaller capacitive resistance than low-frequency currents, by which medium-frequency currents, with its higher frequency, will easily pass through the skin, enabling an easy access to deep lying nerve and muscle tissue without any skin discomfort.

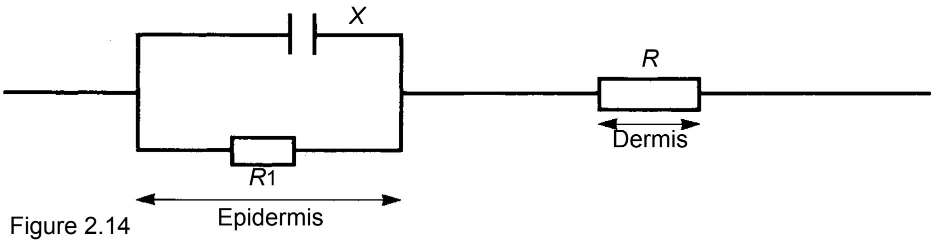


Figure 2.14

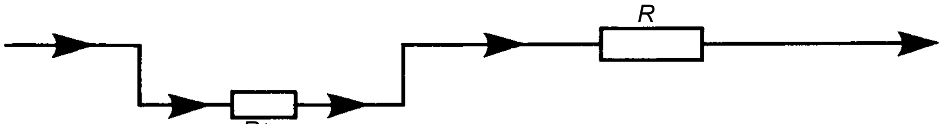


Figure 2.15

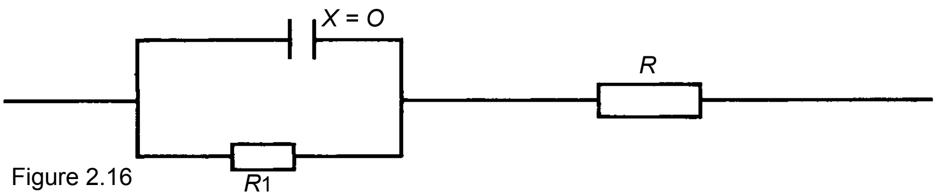


Figure 2.16

2.3.3 Properties of medium frequency alternating current vs direct Current

A direct current (continuous or interrupted) and a rectified low-frequency alternating current can cause obvious stimulation effects in the skin. These effects occur especially in the superficial layers of tissue; consequently deeper structures are hardly or not reached.

There are no galvanic (DC) properties when a symmetrical medium-frequency alternating current is applied, as a result whereof the same electrical and electrolytical processes occur under each electrode. A medium-frequency alternating current is therefore called an apolar current. Low-frequency currents produce an action potential primarily under the cathode.

With an alternating current similar depolarizations, apart from a small phase difference, occur under each electrode. Galvanic properties are absent from medium-frequency alternating currents; hyperaemia will not arise and there is no danger of electrolytic skin effects (etching).

The patient can tolerate medium-frequency alternating currents on the skin much more easily than low-frequency currents. As a consequence of the reduced strain on the skin (no discomfort), the intensity can be increased so that the effect of the current in deep tissue increases.

2.3.4 Conclusion

From the information above we can conclude that the increased efficiency of the depth effect of medium-frequency alternating currents is caused by:

- improved conductivity owing to the reduced capacitive resistance of the skin as a result of the interferential current;
- the absence of galvanic effects.

When a medium-frequency alternating current is applied to human tissue it is found that sensations are perceived more definitely in deep tissue than when direct currents and rectified low-frequency alternating currents are administered. This means that the correct localization of stimulation in deeper layers of tissue is more easily achieved.

In short, we find that forms of direct current and rectified low-frequency alternating current are more suitable for treating superficial layers of tissue while medium-frequency alternating currents are more suitable for treating deeper layers of tissue.

Note: The strain on the skin.

The amplitude of a modulated medium-frequency alternating current depends, among other things, on the method of application. With the four-pole method a modulated alternating current occurs at the point of intersection which amplitude is max. $i\sqrt{2}$ (i is the amplitude of the resultant currents) (see figure 2.17).

The current which is applied to the skin is unmodulated and its amplitude is lower than the modulated current at the point of intersection (see figure 2.9).

With the two-pole method, the modulated current in between the electrodes has at any point in the body the same intensity as immediately under the electrodes.
A considerable depth effect combined with a low strain on the skin are the essential advantages of medium-frequency currents over low-frequency currents. A further reduction of the strain on the skin results from the use of the 4-pole- as opposed to the 2-pole treatment (see paragraph 4.1).

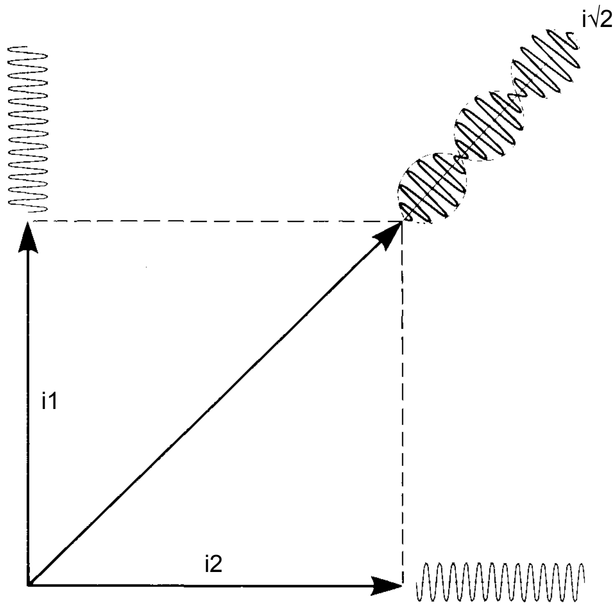


Figure 2.17 . With the four-pole method a modulated alternating current occurs at the point of intersection which amplitude is max. $i\sqrt{2}$ (i is the amplitude of the resultant currents)

3.1 Effect of interferential currents

Electrotherapy enables to stimulate selectively myelinated afferent nerve fibres (thick-nerve fibres), resulting in:
- reduction of pain
- normalization of the neuro-vegatative balance including relaxation and improvement of the circulation

Stimulation of thick afferent nerve fibres has an inhibiting or blocking effect on the activity of thin afferent nerve fibres, and consequently the pain perception is diminished, or not felt at all. Lullies writes in this connection of a 'masking effect' .

Melzack and Wall have explained the effects resulting from stimulation of thick nerve fibres by the "gate control" theory. In addition to reducing pain by stimulation of thick nerve fibres normalization of the neuro-vegetative balance occurs. This means a damping of the orthosympathetic system, which is reflected in relaxation and improvement of the circulation. This also results in pain reduction.

Stimulation of myelinated afferent nerve fibres in muscle or skin tissue causes orthosympathetic reflex discharges which are followed by a spontaneous post-excitation of the orthosympathetic reflex activity. This short-duration interruption of the vicious cycle leads to normalization of the spontaneous activity of the orthosympathetic reflex activity.

Conclusions as to the conditions which sinusoidal alternating currents must meet in order to stimulate thick-nerve fibres can selectively be drawn from Lullies' research. These conditions are:
- a "relatively" low-current intensity
- relatively" high frequency (over 3 Hz).

The intensity of a sinusoidal alternating current plotted against the frequency of the alternating current for A-(alpha) fibres (myelinated motor fibres) and C-fibres(unmyelinatedorthosympathetic fibres) of the sciatic nerve of a frog.

Although the frequency of medium-frequency alternating currents in interferential therapy differs from the optimum frequency, these currents are obviously able to stimulate thick-nerve fibres. The AMF has no effect on the selective stimulation of thick nerve fibres but only determines the frequency with which nerve fibres depolarize. Different AMF's produce different sensations in the patient, so that the current can be adapted to the sensitivity and pathology of the treated tissues (see paragraph 4.4). Therefore the choice of the AMF is of great therapeutic importance.

3.2 Accomodation

It is a well-known fact that a patient subjected to stimulation with a set current feels it less strongly as time proceeds and may even stop feeling anything at all. This process is called *accomodation* and occurs because the stimulated sensors pass on information concerning the external changes in a decreasing degree.

Stimulation with an unchanged stimulus leads to a decrease of the stimulating effect. To prevent accomodation one may choose to *increase either the intensity or to vary the frequency*, and make either variation occur more abruptly or rapidly (see 4.5 on this subject) or set a lower AMF (treatment frequency).

- *Increasing the current intensity.*
  Each time accomodation is noticed, the current intensity can be increased until the patient experiences the former sensation again. This may be repeated a number of times during the course of the treatment. With low-frequency interrupted DC particularly in "Ultra Stimulation" (2-5)-current therapy as practiced by Trabert, use is made of this principle.
  One objection is that with low-frequency rectified direct currents, the quantity of the applied energy might increase to such an extent that the therapy will then have to cease because etching of the skin occurs. This risk does not exist in interferential therapy. However, strong tetanic contractions, which the patient may experience as vigorous, are possible to arise.

- *Varying the frequency.*
  Bernard was the first to use the possibility of preventing accomodation by varying the frequencies. In the CP and LP forms of modulation the 50-Hz and 100-Hz frequencies alternate rhythmically. Use is made of this principle in inferential therapy and the alternation is referred to as the "frequency spectrum". The word spectrum is interpreted as a treatment-frequency range. In this range all frequencies are automatically and rhythmically traversed as superimposed onto a previously chosen base-treatment frequency (AMF).

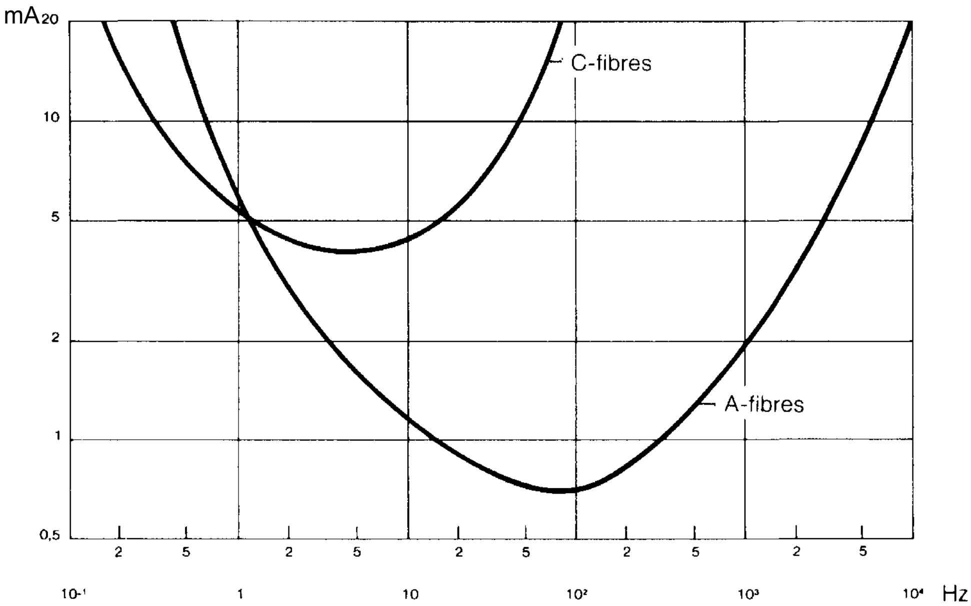


Figure 3.1

Example:

An AMF (base-treatment frequency) of 20 Hz is set and a 50 Hz spectrum is added with a spectrum-sweep program (see figure 3.2 and paragraph 4.5).

The current begins with an AMF (treatment frequency) of 20 Hz and (with a spectrum of 50 Hz) passes successively through all frequencies up to 70 Hz, after which it decreases gradually to 20 Hz. This process is repeated automatically.

- A "broad" spectrum prevents accomodation more effectively than a "narrow" spectrum. Using a broad spectrum frequency marked varying sensations and/or contractions occur.
- Setting a low-base AMF.
  It has been found in practice that selecting a low-base AMF can also prevent accomodation because the patient feels this to be "rougher", "more powerful" or "deeper" (see paragraph 4.4).

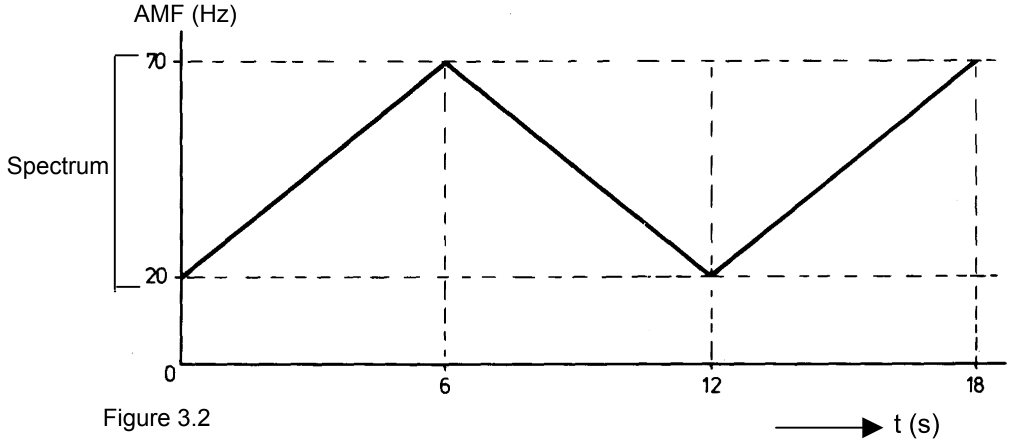


Figure 3.2

4.1 Choice of two-pole or four-pole method

For the choice of method some important points should be taken into account, however, no definite guidelines can be given.

Using the two-pole method the modulation depth is always 100%, while the modulation depth with a four-pole method is 100% only on the 45°-diagonals. As already stated in paragraph 2.2, a 100%-modulation depth has an optimum stimulating effect and as such merits preference in therapy. In practice, to position and fasten two electrodes is easier than four (with the exception of the four-pole pad electrode). Furthermore, searching for correct localization is easier with two electrodes. The four-pole method has the advantage of lower strain on the skin, but this can be of less importance (see paragraph 2.3.4). When medium-frequency alternating currents are applied the strain on the skin is low as a result of the depth penetration owing to the medium frequency of the interferential current and the absence of galvanic properties. The conclusion appears to be justified that the two-pole method is as important as the four-pole method.

4.2 The automatic-vector scan and manual balance

The automatic-vector scan provides an enlargement of the area of effective stimulation (see paragraph 2.2). The localization of optimal stimulation rotates within the area of intersection. The vector technique can be used when it is desirable to treat a large area. If localized effectiveness is desired, the four-pole without automatic-vector scan method is preferred. Using the manual balance allows focusing of the intensity in any localized area within the point of superimposition by rotating the effective area of 100% modulation depth to the required region.

4.3 Choice of electrodes

If either the four-pole or the two-pole method is used, positioning of the electrodes will have to be such that the patient feels the stimulation in the area being treated. Proper localization can be obtained by shifting the electrodes in relation to the tissue and by choosing electrodes of various sizes or kinds. In addition to standard electrodes the following electrodes can be used:

- *The four-pole pad electrode.*
  Four little electodes are located in this square pad which is very suitable for superficial pain points and facial treatments.

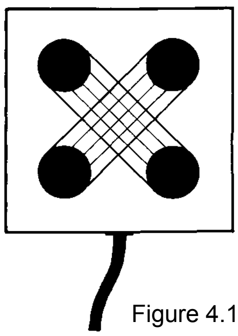


Figure 4.1 Four-pole pad electrode

- *The glove electrode.*
  The use of this electrode is effective in certain cases because it is easily shifted in the course of treatment. During simultaneous use of two glove electrodes it is possible for the patient to regulate the intensity via the manual control.

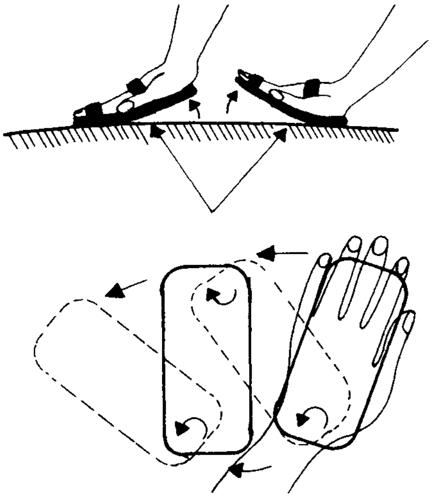


Figure 4.2 Glove electrode

- *The disc or pen electrodes.*
  These electrodes are most suitable for point stimulation.

Figure 4.3a disc electrode

In the two-pole method the effect of the smallest electrode is comparable to the effect of the pen electrode. The current density is greatest under the smallest electrode, so that the latter is suitable for finding and treating pain points. The "indifferent" electrode is best located opposite the stimulating electrode in order to obtain a greater depth effect (see figures 4.4a, b, c, and d).

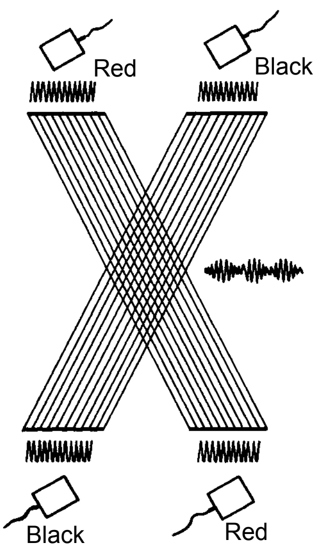


Figure 4.4a Current density
Four-pole application with
electrodes of equal size

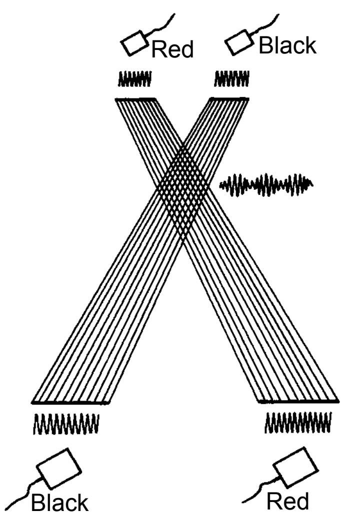


Figure 4.4b Current density
Four-pole application with
electrodes of unequal size

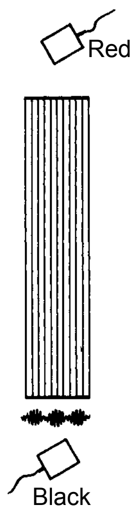


Figure 4.4c
Current density
Two-pole
application with
electrodes of
equal size

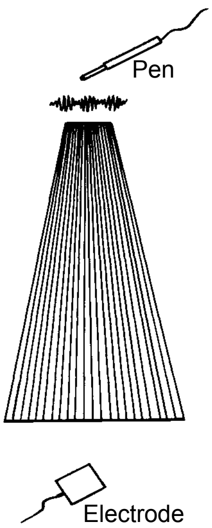


Figure 4.4d
Current density
Two-pole
application with
elctrodes of
unequal size

4.4 Choice of the AMF or treatment frequency

The AMF can be set as desired depending on the nature, the stage, the seriousness, and the location of the disorder. The sensations felt by the patient at the various AMF's have to be considered. High frequencies are felt "comfortable", "more pleasant" or "lighter". It is advised to use a high AMF (75-150 Hz) for acute problems, great pain, hypersensitivity. The use of a high AMF is also to be preferred during an initial treatment if the patient shows a fear of electric stimulation.

At lower frequencies the sensation feels "rougher", "deeper" or "heavier". Frequencies between 25-50Hz tend to produce (tetanic) contractions. With chronic or subacute problems, or if muscular contractions are desired, a low AMF is most suitable. Frequencies below 50Hz produce pulsing, fibrillat-ing contractions.

4.5 Choice of the spectrum.

Accomodation can be avoided by varying the AMF (treatment frequency) (see paragraph 3.2).
The following points are important in selecting a spectrum:

A) The width of the spectrum

The extremes which can be set are:

- *A broad spectrum superimposed onto a low AMF.*
  This will cause markedly varying sensations and/or contractions.
  Use can be made of this form of treatment for complaints which are chronic or subacute.
  A narrow spectrum superimposed onto a low AMF will often be sufficient to prevent accomodation.
- *A narrow spectrum added to a high AMF.*
  In many cases changing sensations are unno-ticeable and accomodation can readily occur. In acute cases, a narrow spectrum will sometimes produce changing sensations. In such cases, however, it is usually found that a large spectrum added to a high AMF is necessary to prevent accomodation.

B) Three programs for changes within the spectrum

The AMF remains at the base frequency for one second and then abruptly changes to the highest frequency, which is also held for one second.
This form of treatment has an aggressive effect and becomes more aggressive as a broader spectrum is chosen. A dramatic effect which can be observed immediately after treatment with this abrupt program is a superficial hyperaemia. This program is recommended for problems which are chronic or subacute and require a bold approach (see figure 4.5).

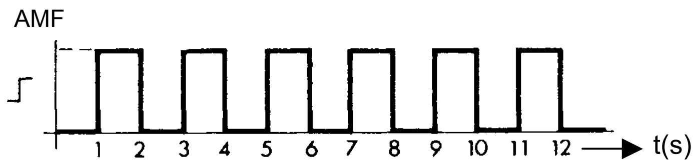


Figure 4.5

The basic frequency is retained for five seconds; then all the frequencies in the set spectrum are traversed in one second up to the highest frequency, which is then maintained for five seconds, whereafter the AMF returns in one second to the lowest set value. This form of treatment is much milder in character and is more easily tolerated by patients with acute disorders (see figure 4.6).

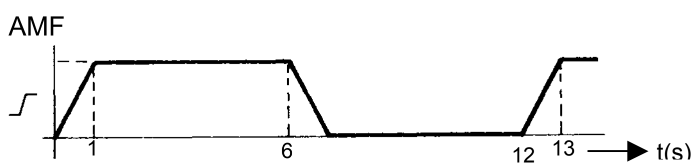


Figure 4.6

In this case frequencies are not kept constant but are continuously changed. In the first six seconds the frequency increases to the highest set frequency and in the next six seconds it decreases again to the basic frequency. Of the three possibilities this last variation is the mildest (see figure 4.7). Despite the spectrum variation a slight increase of the current intensity will be necessary in many cases in order to prevent accomodation.

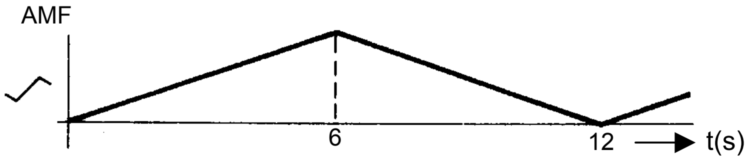


Figure 4.7

4.6 Dosage

4.6.1 Choice of the current intensity

Based on the kind, nature, seriousness, and stage of disorder as well as the effect which the treatment is intended to produce, the practitioner will first have to decide what sensation the patient is likely to experience. The patient can experience the current as minimal (a "mitis" dose), obvious (normal dose), or only just tolerable (a "fortis" dose), and indicates when he feels the required sensation. In fact it is the patient who determines the current intensity, within the limits set by the practitioner. In many cases it is possible to allow the patient himself to control the intensity, by means of a remote intensity control.

4.6.2 Choice of the treatment time

Exact figures cannot be given for the duration of the treatment. The usual periods are about 10 minutes. According to the Bulgarian Professor Liliana Nikolova Troeva, however, times up to 30 minutes might prove suitable. Practice shows that treatment times of only 5 minutes can sometimes lead to the required effect.

The rule of thumb for the dosage is:
In acute cases the dosage chosen must be relatively low, namely a "mitis" dose or normal dose with a short treatment time. In chronic or subacute cases the dosage must be relatively high, namely a normal dose or the "fortis" dose with a longer treatment time.

4.7 Selection of the carrying frequency (2or4KHz)

Clinical use has shown that the use of frequencies of approximately 2,000 Hz produces more motor activity. The current feels rougher and gives maximum stimulation at the muscular level. For muscle strengthening the 2,000-Hz application is found to be preferable for conditions which are not painful (reference paragraph 5.4 "muscular application"). For virtually every other application 4,000 Hz is used.

4.8 Treatment schedule

The treatment schedule is determined on basis of the dosage. With low dosages treatments are administered with short intervals, i.e. daily or several times per day. With high dosages a schedule of three or four treatments per week is recommended. The schedule also depends on the degree of acuteness of the disorder and possible combination with other forms of therapy.

4.9 Indications

The following symptoms are indications for interfe-rential therapy:

- pain (e.g. in muscles, tendons, ligaments, capsules or nerves),
- hypertonia, and
- muscle weakness.

Disorders where above symptoms are indications for interferential therapy:

- disturbances of the neurovegatative balance, leading to disorders of the circulation and organ functions
- post-traumatic and post-operative disorders, such as
    - contusion
    - sprain
    - luxation
    - rupture
    - contracture caused by immobilization
- arthrosis, spondylosis
- periarthritis, bursitis, tendinitis, etc.
- myalgia
- atrophy

4.10 Contra-indications

In addition to contra-indications such as:

- fever
- tumor
- tuberculosis
- unwillingness on the part of the patient

must be taken into account:

- local inflammation
- thrombosis
- pregnancy
- pacemaker
- metal implants if the patient experiences unpleasant sensations

In interferential therapy a classification can be made based on the method of application. A particular application will be chosen based on the application points. The various types are:

- pain-point or trigger-point application
- nerve application
- (para) vertebral application
- muscular application
- transregional application

5.1 Pain-point or trigger-point application

With most disorders pain points or trigger points are found which can be used as application points for therapy. Points in deeper structures such as muscles, tendons, ligaments, joint capsules and bursae are suitable for interferential therapy.

A definition of the term trigger point is ambiguous in literature. It will suffice to give a list of some of its characteristics:

- it is sensitive
- it is a point
- it has no specific relation to the medical indication (*)
- it is located at the common segmental level of the orthosympathetic nervous system
- the disorder is accessible for therapy via the trigger point
- it is not linked to anatomical structures
- it is localized inside or outside the affected area
- its existence is frequently unknown to the patient
- when treated, normalization of the neurovegeta-tive balance occurs
- referred sensation occurs in the affected part spontaneously or upon stimulation.

(*) Note for therapists:
Do not be put off by the fact that the pain point is not initially found where it is to be expected - it is advised to treat that point regardless of its so-called irrelevance positioning.

The two-pole method is the most suitable method for treating pain points and trigger points. In this case a small stimulating electrode (e.g. a disc or pen electrode) is moved along until the patient feels the stimulation in the pain point or trigger point and in the affected part.

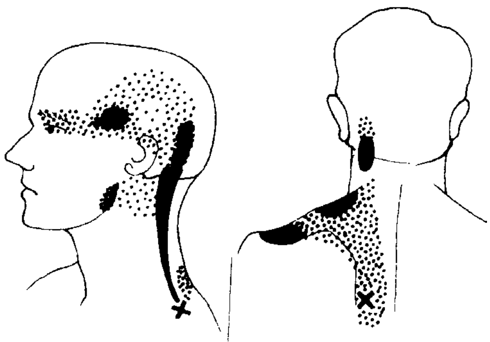


Figure 5.2 m. Trapezius

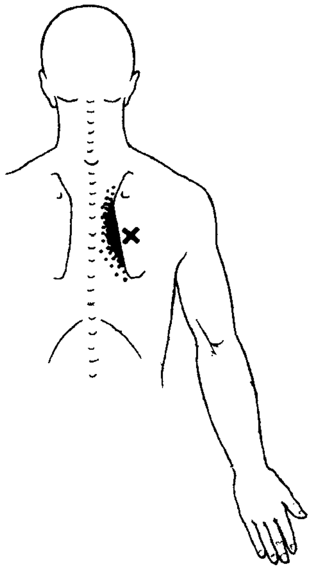


Figure 5.3 m. Infraspinatus

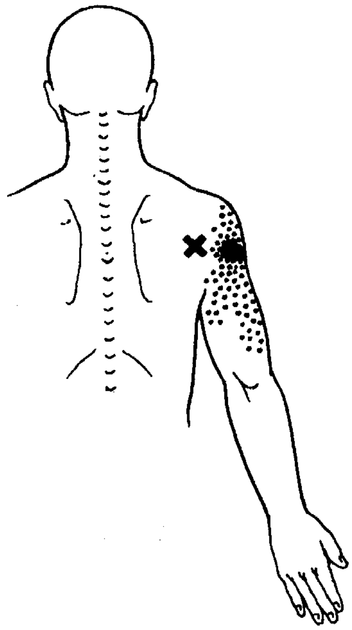
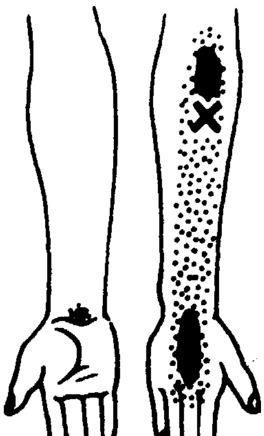


Figure 5.4m Teres Minor



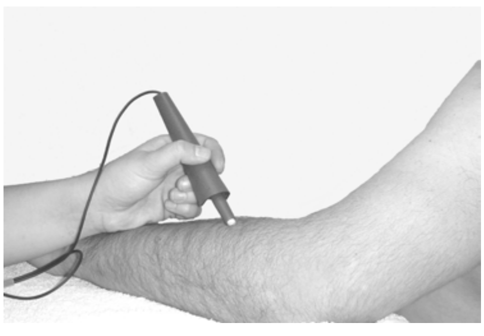


Figure 5.5 m. Extensor Carpi Radialis

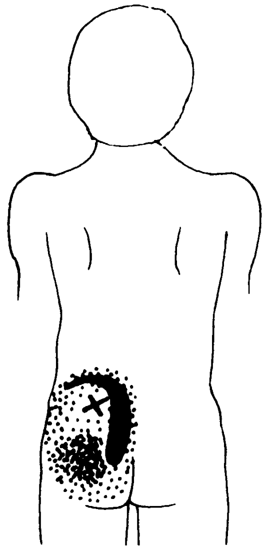


Figure 5.6 Gluteus Maximus

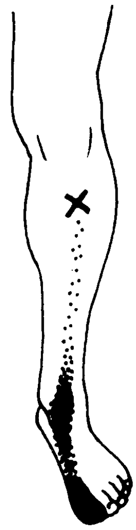


Figure 5.7 m. Tibialis Anterior

5.2 Nerve application

With nerve applications the large myelinated afferent nerve fibres can be treated selectively in various ways. The two-pole method is very suitable here (e.g. for sciatica) (see figure 5.8).
In some cases the unequal size 4-pole pad electrodes are preferred (e.g. for trigeminal neuralgia or occipital neuralgia) (see figure 5.9 and 5.10). In applying this treatment it is important that the patient feels the radiation in the affected part.

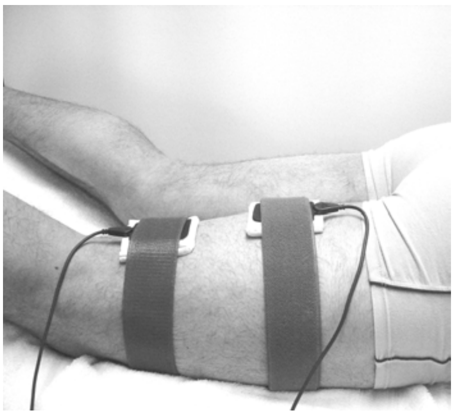


Figure 5.8 Neuralgia of the sciatic nerve:
two-polar treatment along the nerve.

Figure 5.9 Trigeminal Neuralgia

5.3 (Para) vertebral application

The electrodes are positioned near or on the vertebral column for the following symptoms:

- local pain
- cervical pain, e.g. by compression
- hypertonia of the erector trunci muscle
- disturbance of the neurovegative balance

The effect of selective stimulation of large myelinated afferent nerve fibres was discussed in paragraph 3.1. In addition to an analgesic effect normalization of the *neurovegetative* balance also occurs. By stimulating large-nerve fibres at thoraco-lumbar level (C8-L2) (see figure 5.10), segmentally corresponding tissues such as, internal organs, circulation in the cranium and lower or upper extremities, are vegetatively influenced. An inhibition of the sympathetic reflex activity occurs, so that symptoms in the skin, muscles and internal organs due to an excessively high spontaneous activity of the sympathetic nervous system are counteracted.

The level of this reflex activity is dertermined by the level of the spinal sympathetic nervous system of the affected organ. At this level pathological changes can be found in dermatomas, Head´s areas and Mackenszie´s myotome zones. These zones, often with very sensitive points (maximum points or trigger points), form the application point for segmental therapy. For this form of therapy it is necessary to understand the segmentation of the human body (see figure 5.10). With their greater effectiveness for deep tissue as compared to low-frequency galvanic currents, medium-frequency alternating currents are more suitable for treating myotomes and trigger points located in myotomes.

Segmental examination
A searching test comparable to galvanopalpation can be carried out with interferential current. While hyperaesthesia in dermatomas can be located with the aid of galvanopalpation, hyperaesthesia in both dermatomas and myomas can be located with interferential currents. The test using interferential currents is carried out using the two-pole method with a small active electrode and a large indifferent electrode. The current intensity is increased until the patient feels a definite vibration at a fixed frequency of, for example, 100Hz.

The active electrode is slowly moved caudally along the vertebral column. It is advisable to carry out this test at various distances from the vertebral In an over-simulated myotome the patient will experience a deep pressure pain as a result of the current. In the corresponding dermatome, which is shallower, a superficial burning pain will occur. Comparison of the test results on the left and right may provide diagnostic information (see figure 5.11).

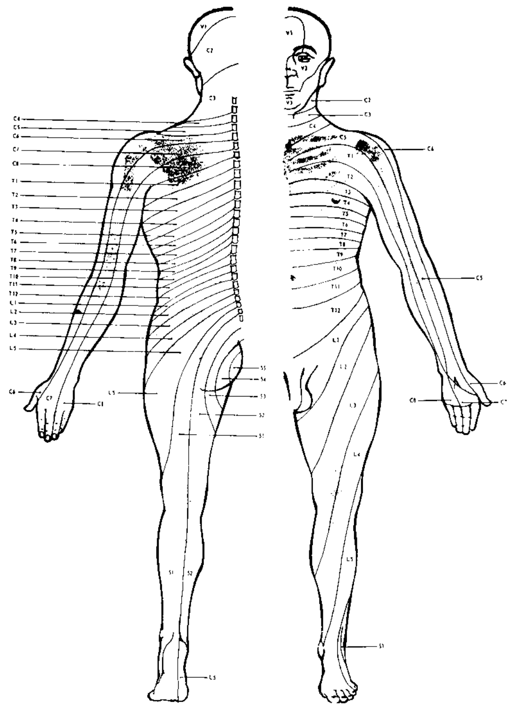


Figure 5.10a

Figure 5.11 segmental examination.

Figure 5.12 electrode localization IV according to TRÂBERT

In this treatment according to Trabert (see fig. 5.12) the "2-5"-current can be substituted by the interferential current (see 3.2). The same electrode positions and the same dosages are then used. A low AMF is chosen e.g. 25 Hz, in order to obtain a subjective sensation comparable with that of the two-five current, as well as changing tetanic contractions (electro-massage). The advantage of interferential current is that etching of the skin cannot occur. This is offset to some extent by the absence of the pronounced hyperaemia resulting from the two-five current. It is advisable to treat patients with sensitive skin alternately with two-five current and interferential current.

5.4 Muscular application

Muscular application is employed when the purpose of the therapy is:

- toning of the musculature,
- improvement of the circulation,
- muscle strengthening
- relaxation of the musculature

The interferential current method is most suitable for muscle treatment because of the little strain imposed on the skin and the marked effect on deep tissue.

Toning of the musculature, improvement of the circulation
Sufficient current intensity and AMF's below 50 Hz, produce clear tetanic contractions. If the contractions do not acquire a persistent character but remain fibrillating, the circulation in the gastrocnemius muscle is promoted (see figure 5.13.)

Muscle strengthening
Koz, a professor in sports medicine at the Moscow State Academy, was the first to use medium-frequency alternating currents for muscle strengthening in prosthesiology and in the training of Russian cosmonauts. In this technique electrostimulation is applied both to individual muscles and to groups of muscles (directly to the muscle or indirectly via the nerve) (see figure 5.14).

With direct stimulation a frequency of 2,500 Hz was found to produce the largest contraction while with indirect stimulation 1,000 Hz proved to be the optimum frequency. Anzil and Zanon demonstrated that supplementary electrostimulation has a positive effect on increasing the maximum isometric muscle strength as compared to the traditional active isometric training.

Figure 5.13 treatment of the gastrocnemius muscle after a rupture.

Figure 5.14 treatment of a quadriceps femoris muscle for strengthening the muscle with a medium-frequency alternating current at 2,000 Hz.

They are convinced on the basis of their investigations that electrostimulation will increasingly become common practice in topsports training.

Muscle strengthening with electrostimulation can be done as follows:

Example:
The patient is instructed to maintain the maximum possible contraction, usually working against a resistance, for a period of 10 seconds followed by 30-50 seconds rest to avoid fatigue. This is easily accomplished by using the remote control which allows setting of the contraction time the surge on- and off-time, the rest time and the intensity.
AMF (or treatment frequencies) around 40-80 Hz produce the most comfortable tetanic contractions
Large electrodes can effectively be used to reduce uncomfortable concentrations of the current and also to recruit the maximum number of muscle fibres. After about four or five strong contractions fatigue usually begins.

Muscle relaxation
In the case of hypertonic and painful musculature interferential therapy can be used to relax tension.

Depending on the acuteness of the pathology, an AMF with a constant frequency is selected. The electrodes are placed on each side of the muscle belly of the trapezius muscle (pars descendens see fig. 5.15). The current must be just tolerable for the patient (a "fortis" dose) and must be felt in the most painful area of the muscle. An obvious contraction must occur. After some time fatigue occurs and the muscle becomes relaxed. When the muscle has relaxed, the intensity should be increased again in order to provoke the next contraction. This alternation between a strong contraction and relaxation of the muscle is repeated several times.

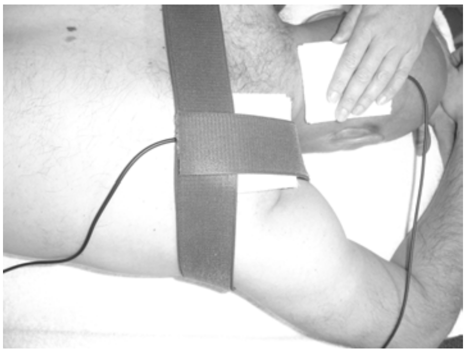


Figure 5.15 treatment of a hypertonic trapezius muscle (pars decendens).

5.5 Transregional application

If any of the foregoing methods proves unsuitable for a disorder because of the absence of clear points in the affected area, a transregional treatment can be indicated. The effect of this application covers a considerable treatment area (see figure 5.16).

Interferential therapy is an excellent means of treating painful disorders. The four-pole method is preferred in these cases. The electrodes are placed and moved until the patient feels the stimulation in the affected area. Focusing on the affected area is accomplished with the balance control. For non-specific or diffuse pain, the automatic vector scan is very effective (see figure 5.17).
Liliana Nikolova-Troeva describes the favourable effect of interferential therapy on patients with traumatic contractures. The current intensity has to be clearly felt by the patient (normal dosage).

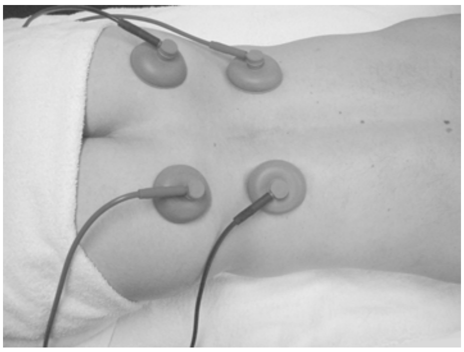


Figure 5.16 treatment of low-back pain.

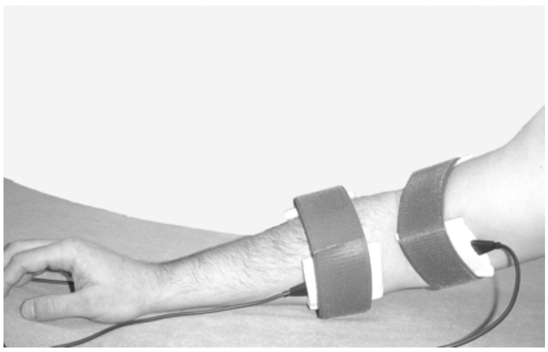


Figure 5.17 treatment of a contracture of a joint, e.g. the elbow

For the purpose of treatment use is made of four electrodes of similar size which are fixed on both sides of the joint. An AMF varying from 0 to 10 Hz provokes muscle contractions with strong fibrillations, improves the trophism of the tissue and produces an analgesic effect. For patients with a great deal of pain and slow callus formation, however, a frequency of 100 Hz is recommended.

Another advantage of the interferential therapy is that - if the patient does not find it to be disagreeable - it can be used for osteosynthesis by means of metal. In comparison with other physiotherapeutic methods, interferential current has a most favourable effect. With the great majority of patients with contractures of the elbow, complete recovery is effected in a short time if the treatment is combined with exercise therapy.

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